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Diffusion In Agar Cubes

Is Bigger Better? OR Is Smaller Smarter?

Adapted from Flinn Scientific Publication No. 10110

**Introduction:**

Diffusion is one of the very important processes by which substances such as nutrients, water, oxygen, and cellular wasted are transported between living cells and their environment. This activity will help you explore the relationship between diffusion and cell size by experimenting with model “cells.”

In this experiment, you will use agar cubes to which the indicator phenolphthalein has been added. Phenolphthalein is an acid/base indicator that turns clear in the presence of an acid such as vinegar. Thus the surface of the agar cubes will turn clear immediately when put into a vinegar solution. The vinegar will continue to diffuse through the cube and gradually turn the inside of the cube clear. The guiding question for this lab is thus:

What determines the efficiency of diffusion throughout the model “cells”? Use this question to help formulate a hypothesis:

**Your hypothesis**:

**Materials:**

Agar

A ruler

200mL of vinegar

Plastic Knife

Large beaker/cup

Spoon

**Procedure**:

1. Each group will have three agar cubes: A 3cm cube, a 2cm cube, and a 1cm cube.
2. Pour 200mL of vinegar solution into your 400mL beaker.
3. Immerse your 3 cubes in the vinegar, noting the time.
4. Let the cubes soak for approximately 10 minutes.
5. Periodically, gently stir the solution, or turn the cubes over.
6. After 10 minutes, use a spoon to remove the cubes from the vinegar.
7. Blot the with a paper towel.
8. Promptly cut each cube in half and measure the depth to which the vinegar has penetrated. Sketch each block’s cross-section.
9. Record your measurements and sketch each cube in the table found on the next page.
10. Do the following calculations for each cube and complete the following data table:

**Calculating % diffusion in each cube:**

* Calculate total volume of each cube (volume = L x W x H)
* Calculate volume that stayed pink.
* Calculate volume diffused = total volume – volume that stayed pink.
* Calculate % diffusion = Volume diffused /total volume x 100

**Calculate the surface area of each cube and the surface area to volume ratio**:

* Calculate the surface area of a cube = L x W x # of sides
* Calculate surface area/volume ratio.

**DATA TABLE: Diffusion in Agar Cubes**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Cube Size** | **Total cube volume (cm3)** | **Total “pink” volume**  **(cm3)** | **Sketch of each**  **Cube** | **Volume of the diffused portion** | PercentDiffusion | **Surface area of cube (cm2)** | **Surface area to volume ratio** |
| 1cm |  |  |  |  |  |  |  |
| 2cm |  |  |  |  |  |  |  |
| 3cm |  |  |  |  |  |  |  |

**Conclusion Questions: *Complete Sentences!***

1. In terms of maximizing diffusion, what was the most effective size cube that you tested?
2. Why was that size most effective at maximizing diffusion? What are the important factors that affect how materials diffuse into cells or tissues?
3. If a large surface area is helpful to cells, why do cells not grow to be very large?
4. You have three cubes, A, B, and C. They have surface to volume ratios of 3:1, 5:2, and 4:1 respectively. Which of these cubes is going to be the most effective at maximizing diffusion, how do you know this?
5. In general, what is the relationship between the SA:V ratio and diffusion time?
6. How does your body adapt surface area-to-volume ratios to help exchange gases?
7. If you use a batch of cake batter for cupcakes instead of cake and bake them for the time recommended for a cake, what will be the result?
8. Why can’t certain cells, like bacteria, get to be the size of a small fish?
9. What are the advantages of large organisms being multicellular?
10. Give an example of a type of cell in a living organism (animal or plant) that is shaped very differently than the classical round or boxy shape that you see drawn in introductory textbook chapters on cells. Explain how that unique shape is tied to the function that those cells perform.